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Relationship between Acceptance and Understanding of the Evolution Theory by Various Groups of Teachers

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Abstract

In this paper a comparison is made among various groups of Serbian teachers (kindergarten teachers, primary school teachers, biologists, physicists, chemists) in terms of the following factors: acceptance and the understanding of evolution theory. In order to accomplish the tasks of this paper, the specific questionnaire model with parallel groups of teachers was applied (involving 341 teachers). The aim was to identify and measure differences in those factors among these large groups of teachers. The results show that biology teachers performed better on accepting and understanding the evolution theory in comparison with other groups of teachers. Also, we determined that there is a positive correlation between the acceptance and understanding the evolution theory for all groups of teachers. The findings indicate a necessity to enhance the evolution teaching contents in the Serbian system of education for groups of teachers who participated in this investigation. Modern teaching processes, at all levels of education, should involve adequate didactically prepared evolution teaching contents and courses.

Key words: *evolution teaching contents; evolution theory; teachers*

Introduction

Evolution theory is the central and unifying theme of biology and has an inimitable place in modern science. Although there is increasing diversity of evidence that supports it, evolution theory is also one of the least understood and least accepted theories of modern science among the general public (Annaç & Bahçekapili, 2012).

The focus of many researchers is to examine the acceptance of evolution theory which refers to acceptance of the scientific validity of evolution theory rather than believing in it (Rutledge i Sadler, 2007). Some studies relating to the acceptance of evolution theory have shown that there were unsatisfactory levels of acceptance (Rutlegde i Warden, 2000; Peker, Comert, & Kence, 2010). Researchers have been exploring those factors which were thought to be connected to the acceptance of evolution theory. One of the factors affecting the acceptance of evolution theory can be interpreted as individuals' content knowledge about evolution theory (Akyol, Tekkaya, & Sungur, 2010). There are many studies that examined the relationship between understanding and acceptance of evolution theory (Bishop & Anderson, 1990; Demastes, Settlage, & Good, 1995; Deniz, Donelly, & Yilmaz, 2008; Rutlegde & Warden, 2000; Sinatra, Southerland, McConaughy, & Demastes, 2003; Nadelson & Sinatra, 2009; Peker i sur., 2010). Some studies indicate significant relationships (Deniz i sur., 2008; Peker i sur., 2010; Rutlegde & Warden, 2000), while results from other research have shown that understanding is not significantly associated with acceptance of evolution theory (Bishop & Anderson, 1990; Demastes i sur., 1995; Sinatra i sur., 2003). Similarly, some studies point that acceptance of evolution can be reversed as a result of evolution instruction (Lawson & Weser, 1990; Matthews, 2001), whereas others suggest that it does not change (Bishop & Anderson, 1990; Lawson & Worsnop, 1992). From these studies, it can be concluded that the relationship between acceptance and understanding is very complex.

Based on the literature review, it can be claimed that the acceptance of evolution theory (ET) is related to a number of different factors. In the context of conceptual change perspectives in science education, there is an evident presumption that people can revise their views on one topic or in one scientific domain without the need to change anything else about their lives or their identities (Athanasiou & Papadopoulou, 2011). According to Lemke (2001), this is in contrast with the experience of sociocultural research. The acceptance of ET as a part of the conceptual ecology (Posner, Strike, Hewson, & Gertzog, 1982; Strike & Posner, 1992) for biological evolution is better than studying the acceptance of evolutionary theory in isolation. In this theoretical frame, the basic importance of a number of factors in controlling learning is recognized (Strike & Posner, 1992). These factors tend to change the conceptual environment in which conceptual change occurs. Conceptual ecology controls and modifies this process (Strike & Posner, 1992). This modified conceptual change model is called a "revisionist theory of conceptual change" and the importance of the roles of intuition, emotion, motives, and social factors was proven (Strike & Posner, 1992). Factors known as learner's "conceptual ecology" of evolution theory are documented in previous research (Demastes, Good, & Peebles 1995a, Deniz i sur., 2008). They described that conceptual ecology for biological evolution contains the following components: acceptance of ET; prior conceptions related to evolution - understanding of ET; scientific orientation (degree to which the learner organizes his/

her life around scientific activities); view of the nature of science; view of the biological world in competitive and causal terms as opposed to aesthetic terms; religious orientation, reasoning level; perceptions of the impact of the ET; epistemological beliefs; and thinking dispositions. Deniz i sur. (2008) added parents' educational level as a factor related to ET acceptance.

The relationships between acceptance and understanding of evolution theory have been studied extensively in many countries. However, there was not any effort to investigate such relations in Serbia. Although, available studies regarding related issues produced different results, we chose to conduct a comparative study about the ways in which teachers differ in subject matter knowledge, according to the Nehm, Kim and Sheppard (2009) methodology.

Founded on previous research, this comparative study focused on factors which make up the conceptual ecology of the evolution theory of Serbian teachers. From the afore-mentioned factors we chose to investigate the acceptance and understanding of evolution theory – comparatively presented in this study.

The following research questions are at issue in this study: (1) What are the levels of acceptance and understanding of evolution theory for the above mentioned groups of Serbian teachers? (2) Are there any relationships among acceptance and understanding of the ET? (3) Are there any differences among Serbian teachers in this case?

The aim was to identify and measure those differences, as well as compare the stated factors for all groups of teachers.

Materials and Methods

The study included 341 Serbian teachers in total, who participated in this investigation. There were several groups of teachers: 53 teachers of early childhood education-kindergarten teachers, 70 primary teachers and 218 secondary science teachers (74 biologists, 73 physicists, 71 chemists).

In order to complete the tasks of this research, the model of parallel groups of teachers was applied. All groups were administered an extensively structured questionnaire. The questionnaire was focused on two factors related to evolution theory (acceptance of evolution theory, understanding of evolution theory). Teachers also had to respond to the five demographic questions referring to gender, age, studies, and teaching experience (Appendix).

To assess the acceptance of evolution theory, the MATE scale (Measure of Acceptance of the Theory of Evolution) was used. It was developed by Rutledge and Warden (2000). MATE scale has twenty Likert scale items that addressed the fundamental concepts of evolution theory and the nature of science (Rutledge & Sadler, 2007). To score the MATE scale, the procedure developed by Rutledge and Warden (1999) was applied.

Teachers' understanding of evolution theory was estimated by means of a scale (adopted from Rutledge and Warden (2000) and adapted for the needs of the study)

with 13 questions arranged into two sub-scales. The first one consisted of 8 questions that had to do with understanding of very basic principles of the evolution theory (Correct-False-Do not know: probable answer). The second sub-scale had 5 multiple choice questions, which concerned understanding of procedures and practices on the evolution of populations. Scoring was performed through a scaling where the correct response to a statement received a score of 1, whereas incorrect response received a score of 0 (possible total scores min=0, max=13).

After applying the questionnaire, data and results processing was performed using basic statistical methods/table-descriptive statistics (means, standard deviation and maximum and minimum of responses) with PASW Statistics 18.

Findings and Discussion

The structure of the sample (expertise, gender, age, years of experience and postgraduate studies) is presented in Tables 1, 2, 3, 4, 5.

Table 1. *Teachers' scientific expertise*

Expertise	N	%
Kindergarten teacher	53	15.5
Primary teacher	70	20.5
Science secondary teachers	218	63.9
Biologists	74	21.7
Physicists	73	21.4
Chemists	71	20.8
Total	**341**	**100**

Considering the structure of the sample, it can be seen that a large part of the sample consists of secondary teachers (63.9%), and the number of biologists, chemists and physicists was nearly identical.

Table 2. *Participants' gender*

Gender	N	%
Male	77	22.6
Female	264	77.4
Total	**341**	**100**

Women make up 77.4% of the sample, while only 22.6% are male participants.

Table 3. *Participants' age*

Age group	N	%
<30	55	16.1
31-40	97	28.4
41-50	110	31.1
>50	79	24.4
Total	**341**	**100**

The largest number of teachers who participated in this study is in the 31-40 years (28.4%) and 41-50 years (31.1%) age groups. The smallest number of teachers belongs to the 30 years old and less age group.

Table 4. *Teaching experience*

Years of experience	N	%
1-10	118	34.6
11-20	105	30.8
21-30	86	25.2
>30	12	9.4
Total	**341**	**100**
Min=1	Max=38	SD=10.04

Taking into account teaching experience, the highest percentage is of those who have 1-10 years of teaching experience, while only 9.4% of teachers have more than 30 years of experience.

Table 5. *Participants with postgraduate studies*

Postgraduate studies	N	%
Yes	50	14.7
No	291	85.3
Total	**341**	**100**

Only 14.7% of the total numbers of teachers have completed postgraduate studies.

Table 6 and Table 7 present the mean scores, standard deviations and standard errors of mean, in acceptance and understanding ET scores of all teachers participating in our study. We also present the scores, standard deviations and standard errors of mean, both in acceptance and understanding ET, recorded by teachers of different subject matter knowledge i.e. biologists, physicists and chemists.

Table 6. *Acceptance of evolution theory by Serbian teachers*

	M	SD	SM
Acceptance of evolution theory – MATE scale			
Total score *(possible min=20, max=100)*	76.18	9.821	0.532
Kindergarten teachers	69.68	7.450	1.023
Primary teachers	73.99	10.214	1.221
Secondary teachers	78.46	9.356	0.634
Biology teachers	84.56	8.099	0.941
Physicists	71.93	7.032	0.823
Chemists	78.82	8.254	0.980

a) ***Acceptance:***

Following the categorization developed by Rutledge and Sadler (2007), the acceptance level is moderate for the total cohort (mean score: 76.18). The highest

score is recorded in the group of biology teachers (mean score: 84.56-high level). The lowest score is recorded in the group of kindergarten teachers (69.68).

In groups of science teachers, the acceptance level is high (mean score: 78.46), mostly due to biologists, but also chemists who have a high score (mean score: 78.82).

By observing the Secondary teachers group, we can see that they performed better than Primary and Kindergarten teachers.

Some of these differences are significant (Primary – Kindergarten teachers, mean difference = 4.31, sig<0.05. Secondary – Primary School teachers, mean difference = 4.48, sig<0.01. Secondary – Kindergarten teachers, mean difference = 8.78, sig<0.01).

Biology teachers obtained better results in comparison to other groups of teachers. However, that was expected considering their scientific background (education). We can see that significant differences are observed between Biologist – Chemists, mean difference = 5.75, sig<0.01, Biologists – Physicists, mean difference = 12.64, sig<0.01.

Table 7. *Understanding of evolution theory by Serbian teachers*

	M	SD	SM
Understanding of evolution theory			
Total score *(possible min=0, max=13)*	5.82	1.949	0.106
Kindergarten teachers	4.42	1.715	0.236
Primary teachers	5.31	1.814	0.217
Secondary teachers	6.34	1.839	0.125
Biology teachers	7.24	1.542	0.179
Physicists	5.59	1.928	0.226
Chemists	6.13	1.638	0.194

b) ***Understanding:***

For all groups of teachers, the understanding levels are very low (total mean score: 5.82).

Secondary science teachers performed better in the understanding score than Primary and Kindergarten teachers. The highest score was obtained by secondary teachers (mean score: 6.34), and the lowest score was obtained by Kindergarten teachers (mean score: 4.42).

Some of these differences are significant, namely: Secondary – Kindergarten teachers, mean difference = 1.91, sig<0.01, Secondary – Primary teachers, mean difference = 1.01, sig<0.01 and Primary – Kindergarten teachers, mean difference = 0.90, sig<0.05.

A higher score was noted for the biology teachers in comparison to other groups of teachers. This result is consistent with the fact that biology teachers are presented with evolution teaching content during their education. The result is slightly better, but their score level is still low. There are significant differences in the understanding score between: Biologists – Physicists, mean difference = 1.65, sig<0.01 and Biologists – Chemists, mean difference = 1.12, sig<0.01.

c) *Correlations:*

Table 8 shows the correlation (Pearson) between the examined factors (acceptance and understanding of evolution theory) for Serbian teachers (overall).

Table 8. *Correlation (Pearson) between the acceptance and understanding of evolution theory (ET) (* significant, p<0.01).*

	1	2
1. Acceptance of E.T.	1	
2. Understanding of E.T.	0.353*	1

In Table 8 we can see that there is a positive significant correlation between accepting and understanding the evolution theory for all groups of Serbian teachers (r=0.353, p<0.01). The results indicate that the strength of association between the acceptance and understanding of ET is high (r=0.353), and that the correlation coefficient is highly significantly different from zero (p<0.01). A positive correlation indicates that both variables increase or decrease together.

Our findings can be compared with the results from other studies which investigate the acceptance of ET (measured with MATE scale). A recent comparative study of Greek teachers showed that Greek teachers performed better in understanding evolution theory in comparison with groups of Serbian teachers. There is no significant difference between Greek and Serbian teachers regarding the acceptance of the evolution theory overall but there are significant differences between various teachers' groups (Papadopoulou i sur., 2011).

The results of Serbian biology teachers are very similar to Oregon biology teachers who achieved 85.90 of the mean score for acceptance (Trani, 2004). Turkish pre-service biology teachers achieved only 50.95 of the mean score for acceptance (Deniz i sur., 2008) and this was low achievement in comparison with the results of all groups of Serbian teachers. Serbian biology teachers also have a better mean score for acceptance in comparison with Indiana biology teachers who achieved 77.59 of the mean score for acceptance (Rutledge & Warden, 2000).

Taking into account other categories of teachers, secondary and primary school teachers from New Zealand achieved 84.55 of the mean score for acceptance (Campbell & Cook, 2003), which is very similar to the results of Serbian biology teachers. Non-biology majors from the United States achieved only 55.87 of the mean score (Rutledge & Sadler, 2007) which is a very low score in comparison to the results of all Serbian teachers groups.

Our findings indicate that understanding of the evolution theory was related to accepting the evolution theory. These findings are consistent with other findings (Rutledge & Warden, 2000; Johnson & Peeples, 1987; Deniz i sur., 2008; Peker i sur., 2010). There are some studies which have confirmed no significant correlation between these variables (Akyol i sur., 2010; Annaç & Bahçekapili, 2012; Brem, Ranney, & Schindel, 2003; Demastes i sur., 1995a; Sinatra i sur., 2003).

Conclusions and Implications

Based on the results presented for the Serbian groups of teachers, it can be concluded that there are differences in accepting and understanding the ET among groups of Serbian teachers with respect to their education background.

The acceptance levels are moderate for the total cohort. For the group of Secondary teachers the acceptance level is high. Biology teachers obtained better results in comparison with other groups of teachers. The lowest score is recorded for the group of Kindergarten teachers.

The levels of understanding are also very low. There are statistically significant differences among the groups of teachers. Particularly significant are differences for Kindergarten teachers who obtained the lowest scores.

Biology teachers have higher scores for understanding and acceptance in comparison with other groups of science teachers (Chemists, Physicists). Also, they have better scores than groups of primary and kindergarten teachers. This can be explained by the presence of a significant amount of evolution teaching content in their studies, in comparison with other groups of teachers who have the less evolution teaching content in their studies.

Also, we determined that there is a positive correlation between the acceptance and understanding of the evolution theory by Serbian teachers.

Low levels of accepting ET and understanding ET represent challenges that Serbian educational systems need to address if they hope to provide legitimate biological education. The better results performed by biology teachers (for Acceptance ET and Understanding ET) in correlation with other groups of teachers, can be explained by the existance of the evolution teaching content in their studies. Also, in Serbia, all evolution teaching contents have bad explanations in lessons in textbooks for all levels of biology teaching (primary school, secondary school and even university level, i.e. Faculty of Biology). Our findings indicate that several recommendations can be made in order to promote the understanding and acceptance of evolutionary theory:

- There is a necessity to enhance the evolution teaching contents in the Serbian education system for all groups of teachers (who participated in this investigation), especially for Kindergarten and Primary teachers.
- There is a need to change and didactically prepare all evolution teaching content, especially in textbooks and courses. Thus, it will be more suitable for acquiring knowledge in this teaching area.
- The proper placement of teaching and learning about evolution in the general structure of biology courses and teaching may result in an increase of its acceptance. Athanasiou and Papadopoulou (2011) indicate that one such case may be a biology course organized around evolution as its teaching framework.
- Teachers would benefit from more training in evolutionary science, which would be adequately didactically prepared. Many teachers come to class with erroneous prior conceptions about evolution (Pigliucci, 2007). When these erroneous

conceptions are made explicit and dealt with, accepting and understanding of evolution is better promoted (Verhey, 2005; Robbins & Roy, 2007). Their attitudes and understanding of evolution may have an influence on instructional decisions about the teaching of evolution in their classrooms.

If the above recommendations were widely applied, the process of teacher education in this area of teaching would be of a much better quality.

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Appendix. Questionnaire about acceptance and understanding of the evolution theory

A. Demographic information

1. Gender

Male ☐ Female ☐

2. Age

☐ <30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ >60

3. Expertise

☐ Biologist ☐ Chemist ☐ Physicist ☐ Primary teacher ☐ Kindergarten teacher

4. Years of teaching experience ☐

5. Postgraduate studies ☐

B. ACCEPTANCE OF THE EVOLUTION THEORY (MATE Scale)

1=Strongly Disagree, 2=I Disagree, 3=I have not an opinion, 4=I agree, 5=I strongly Agree

	1	2	3	4	5
1. Evolution is a scientifically valid theory.					
2. Organisms existing today are the result of evolutionary processes that have occurred over millions of years.					
3. The theory of evolution is based on speculation and not valid scientific observation and testing.					
4. Modern humans are the product of evolutionary processes which have occurred over millions of years.					
5. There is a considerable body of data which supports evolutionary theory.					
6. Most scientists accept evolutionary theory to be a scientifically valid theory.					
7. The theory of evolution is incapable of being scientifically tested.					
8. The theory of evolution cannot be correct since it disagrees with the Biblical account of creation.					
9. With few exceptions organisms on earth came into existence at about the same time.					
10. The age of the earth is less than 20,000 years.					
11. The theory of evolution brings meaning to the diverse characteristics and behaviors observed in living things.					
12. Evolutionary theory generates testable predictions with respect to the characteristics of life.					
13. Organisms exist today in essentially the same form in which they always have.					
14. Evolution is not a scientifically valid theory.					
15. Much of the scientific community doubts if evolution occurs.					
16. Current evolutionary theory is the result of sound scientific research and methodology.					
17. Evolutionary theory is supported by factual, historical, and laboratory data.					
18. Humans exist today in the same form in which they always have.					
19. The age of the earth is approximately 4–5 billion years.					
20. The available evidence is ambiguous as to whether evolution occurs.					

C. UNDERSTANDING OF THE EVOLUTION THEORY

1=Correct, 2=False, 3=I don't know

	1	2	3
1. The evolution theory proposed by Charles Darwin was about (concerned) the spontaneous generation of the new organisms.			
2. Evolution is about the humans' descendance from monkey-like ancestors.			
3. The first animals to settle on land probably partially depended upon water for survival.			
4. According to Darwin, individuals in a population tend to reproduce at a geometrical growth rate.			
5. In Darwin's era, the accurate mechanisms explaining genetic inheritance were not widely known.			
6. In (Modern) Darwin's (Darwinian) theory it was suggested that modifications an organism acquires during its lifetime can be passed on to its offspring.			
7. According to the theory of natural selection, populations change through time in response to environmental changes.			
8. Lamarck's main idea in evolutionary process concerned the inheritance of acquired characteristics.			

9. Individuals in a mammal species tend to be genetically different. The primary mechanism generating this genetic variability is:
   A. Meiosis
   B. Mitosis
   C. Poliploidy
   D. Duplications

10. The wing of the bat and the fore-limb of the dog are said to be homologous structures. This indicates that:
   A. They have the same structure.
   B. Bats evolved from a lineage of dogs.
   C. They are structures which are similar due to common ancestry.
   D. They have a different ancestry but a common function.

11. Marine mammals have many structural characteristics in common with fishes. The explanation that evolutionary theory would give for this similarity is:
   A. Fish and mammals are closely related.
   B. Fish evolved structures similar to those existing in mammals.
   C. Marine mammals evolved directly from fishes.
   D. Marine mammals adapted to an environment similar to that of the fishes.

12. Dating by use of the radioactive carbon method:
   A. Helps in dating the remains of organisms but is able to identify a short time span (40,000 years).
   B. Helps in dating the remains of organisms and is able to identify a long time span.
   C. Is not a reliable (trustworthy) technique.
   D. Is used only with rocks, not with organisms' remains.

13. An alternation in the arrangement of nucleotides in a chromosome, possibly resulting in either a structural or a physiological change in the organism is called:
   A. Genetic drift
   B. A mutation
   C. Natural selection
   D. A recessive gene.

Odnos između prihvaćanja i razumijevanja teorije evolucije različitih skupina nastavnika

Sažetak

U radu je napravljena usporedba različitih skupina nastavnika iz Srbije (odgajatelji, učitelji, nastavnici biologije, fizike i kemije) u pogledu prihvaćanja i razumijevanje teorije evolucije.

Primijenjen je model posebnog upitnika s paralelnim skupinama nastavnika (ukupno 341 nastavnik). Cilj je bio utvrditi i izmjeriti razlike. Rezultati pokazuju da nastavnici biologije pokazuju bolje rezultate u prihvaćanju i razumijevanju teorije evolucije u odnosu na druge skupine nastavnika.

Utvrdili smo da postoji pozitivna korelacija između prihvaćanja i razumijevanja teorije evolucije za sve skupine nastavnika.

Rezultati pokazuju nužnost poboljšanja nastavnog sadržaja evolucije u obrazovnom sustavu Srbije za skupine nastavnika koji su sudjelovali u istraživanju. Moderna nastava na svim razinama obrazovanja treba uključiti odgovarajuće didaktičke pripremljene nastavne sadržaje i tečajeve o teoriji evolucije.

Ključne riječi: *evolucijski nastavni sadržaji; nastavnici; teorija evolucije*

Uvod

Teorija evolucije središnja je i ujedinjujuća tema biologije i ima jedinstveno mjesto u modernoj znanosti. Iako je povećana raznovrsnost dokaza koji je podržavaju, teorija evolucije je također jedna od najmanje shvaćenih i najmanje prihvaćenih teorija moderne znanosti u široj javnosti (Annaç i Bahçekapili, 2012).

U središtu pozornosti mnogih istraživača jest studiranje prihvaćanja teorije evolucije koje se odnosi na prihvaćanje znanstvene valjanosti teorije evolucije, a ne vjerovanje u nju (Rutledge i Sadler, 2007). Neke studije u vezi s prihvaćanjem teorije evolucije pokazale su da postoje nezadovoljavajuće razine prihvaćanja (Rutlegde i Warden, 2000; Peker, Comert i Kence, 2010). Istraživači su ispitivali čimbenike za koje se smatra da su povezani s prihvaćanjem teorije evolucije. Jednim od čimbenika koji

utječe na prihvaćanje teorije evolucije može se smatrati količina znanja pojedinca o teoriji evolucije (Akyol, Tekkaya i Sungur, 2010). Postoje mnoge studije koje ispituju odnos između razumijevanja i prihvaćanja teorije evolucije (Bishop i Anderson, 1990; Demastes, Settlage i Dobar, 1995; Deniz, Donelly i Yilmaz, 2008; Rutlegde i Warden, 2000; Sinatra, Southerland, McConaughy i Demastes, 2003; Nadelson i Sinatra, 2009; Peker i sur., 2010). Neke studije pokazuju značajne odnose (Deniz i sur., 2008;. Peker i sur., 2010;. Rutlegde i Warden, 2000), dok su rezultati iz drugih pokazali da razumijevanje nije značajno povezano s prihvaćanjem teorije evolucije (Bishop i Anderson , 1990; Demastes i sur., 1995; Sinatra i sur., 2003) Slično, neke studije ukazuju na to da se prihvaćanje evolucije može preokrenuti kao rezultat nastave evolucije (Lawson i Weser, 1990; Matthews, 2001), dok drugi sugeriraju da se to ne mijenja (Bishop i Anderson, 1990; Lawson i Worsnop, 1992). Iz tih studija može se zaključiti da je odnos između prihvaćanja i razumijevanja vrlo složen.

Na temelju analize literature, može se tvrditi da je prihvaćanje teorije evolucije (ET) povezano s nizom različitih čimbenika. U kontekstu perspektive konceptualnih promjena u znanstvenom obrazovanju evidentna je pretpostavka da ljudi mogu revidirati svoje mišljenje o jednoj temi ili o jednom znanstvenom području, bez potrebe za promjenom bilo čega drugog u svojim životima i njihovim identitetima (Athanasiou i Papadopoulou, 2011). Prema Lemkeu (2001), to je u suprotnosti s iskustvom sociokulturalnog istraživanja. Prihvaćanje ET kao dijela konceptualne ekologije (Posner, Strike, Hewson i Gertzog, 1982; Strike i Posner, 1992) za biološku evoluciju bolje je nego studiranje prihvaćanja teorije evolucije u izolaciji. U tom teorijskom okviru prepoznat je osnovni značaj niza čimbenika u kontrolnom učenju (Strike i Posner, 1992). Ti čimbenici imaju tendenciju promijeniti konceptualno okruženje u kojem se konceptualne promjene događaju. Konceptualna ekologija kontrolira i mijenja taj proces (Strike i Posner, 1992). Taj model modificirane konceptualne promjene zove se "revizijska teorija konceptualnih promjena" i dokazana je važnost uloge intuicije, emocija, motiva i društvenih čimbenika (Strike i Posner, 1992). Čimbenici koji su zajedno nazvani učenička "konceptualna ekologija" teorije evolucije dokumentirani su u prethodnom istraživanju (Demastes, Good i Peebles 1995; Deniz i sur., 2008). Oni su opisali kako konceptualna ekologija za biološku evoluciju sadrži sljedeće komponente: prihvaćanje ET, prije koncepcija vezanih uz evoluciju – razumijevanje ET, znanstvenu orijentaciju (stupanj u kojem učenik organizira svoj život o znanstvenim aktivnostima); pogled na prirodu znanosti, pogled na biološki svijet u konkurentnim i uzročnim uvjetima, za razliku od estetskog smisla, vjersko opredjeljenje, razina razumijevanja, percepcija utjecaja ET; epistemološka uvjerenja, razmišljanja i sklonosti. Deniz i suradnici (2008) dodali su stupanj obrazovanja roditelja kao čimbenik vezan uz prihvaćanje ET.

Veza između prihvaćanja i razumijevanja teorije evolucije bila je intenzivno proučavana u mnogim zemljama. No nije bilo napora da se istraže takvi odnosi u Srbiji. Iako nam dostupne studije koje se bave sličnom temom daju različite rezultate,

odlučili smo provesti komparativnu studiju na sljedeći način – među nastavnicima različitih predmeta, prema Nehm, Kim i Sheppardu (2009), metodološki.

Na temelju prethodnog istraživanja ova komparativna studija fokusira se na čimbenike koji čine konceptualnu ekologiju teorije evolucije nastavnika iz Srbije. Iz navedenih čimbenika odlučili smo istražiti prihvaćanje i razumijevanje teorije evolucije.

U straživanju se bavimo ovim pitanjima: (1) Kakve su razine prihvaćanja i razumijevanja teorije evolucije za navedene skupina nastavnika iz Srbije? (2) Postoje li odnosi između prihvaćanja i razumijevanja ET? (3) Postoje li razlike među nastavnicima iz Srbije?

Cilj je bio utvrditi i izmjeriti razlike, kao i usporediti čimbenike u svim skupinama nastavnika.

Materijali i metode

U istraživanju je sudjelovao ukupno 341 nastavnik iz Srbije. Bilo je nekoliko skupina nastavnika: 53 odgojitelja, 70 nastavnika razredne nastave i 218 nastavnika predmetne nastave (74 nastavnika biologije, 73 nastavnika fizike, 71 nastavnik kemije).

Kako bi se postigli zadaci istraživanja, primijenjen je model paralelnih skupina nastavnika. Sve skupine popunjavale su složeno strukturiran upitnik. Upitnik se od ticao dva čimbenika vezana uz teoriju evolucije (prihvaćanje teorije evolucije, razumijevanje teorije evolucije). Nastavnici su također morali odgovoriti na pet demografskih pitanja: spol, dob, studij i nastavno iskustvo (Dodatak).

Za procjenu prihvaćanja teorije evolucije korištena je MATE ljestvica (Mjera prihvaćanja teorije evolucije). Razvili su je Rutledge i Warden (2000). MATE ljestvica ima dvadeset Likert-skaliranih stavki koje se odnose na temeljne pojmove teorije evolucije i prirode znanosti (Rutledge i Sadler, 2007). Mate ljestvice, postupak Rutledge i Warden (1999) primijenjeni su zbog bodovanja.

Nastavničko razumijevanje teorije evolucije procijenjeno je s pomoću ljestvice [usvojene od Rutledge i Warden (2000) i prilagođene za potrebe ove studije] s 13 pitanja raspoređenih u dvije podskale. Prva od njih sastoji se od 8 pitanja koja su imala veze s razumijevanjem temeljnih načela teorije evolucije (Odgovori: Točno, netočno, ne znam, možda). Druga podskala imala je 5 pitanja višestrukog izbora koja su se odnosila na razumijevanje postupaka i praksi o evoluciji populacija. Bodovanje je provedeno skaliranjem. Točan odgovor na tvrdnju dobiva 1 bod, a netočan odgovor dobiva 0 bodova (ukupno mogućih bodova min = 0, maks = 13).

Nakon realizacije upitnika, obrada podataka i rezultata provedena je primjenom osnovne statističke metode / table-deskriptivne statistike (srednje vrijednosti, standardna devijacija i maksimum i minimum odgovora na upitniku) s PASW Statistikom 18.

Rezultati i diskusija

Struktura uzorka (stručnost, spol, dob, godine iskustva i poslijediplomski studiji) prikazana je u tablicama 1., 2., 3., 4., 5.

Tablica 1.

S obzirom na strukturu uzorka vidljivo je da se velik dio uzorka sastoji od nastavnika predmetne nastave (čak 63,9%), odnosno da je broj biologa, kemičara i fizičara gotovo ujednačen.

Tablica 2.

Žene čine 77,4% ispitanika, a muškarci samo 22,6%.

Tablica 3.

Najveći broj nastavnika koji su sudjelovali u istraživanju je u starosnim skupinama od 31 do 40 godina (28,4%) i od 41 do 50 godina (31,1%). Minimalni broj nastavnika je od 30 godina i manje.

Tablica 4.

Uzimajući u obzir nastavno iskustvo, najveći je postotak onih koji imaju od 1 do 10 godina nastavnog iskustva, dok samo 9,4% nastavnika ima više od 30 godina iskustva.

Tablica 5.

Samo 14,7% od ukupnog broja ispitanih nastavnika završili su poslijediplomske studije.

U tablicama 6. i 7. prisutne su srednje vrijednosti, standardne devijacije i standardne pogreške u bodovanju prihvaćanja i razumijevanja ET svih nastavnika koji su sudjelovali u istraživanju. Također smo predstavili rezultate, standardne devijacije i standardne pogreške, u prihvaćanju i razumijevanju ET u nastavnika različitih predmeta, odnosno biologa, fizičara i kemičara.

Tablica 6.

a) ***Prihvaćanje:***

Nakon kategorizacije razvijene od Rutledge i Sadler (2007), razina prihvaćanja je umjerena u ukupnoj skupini (srednja vrijednost: 76,18). Najveći rezultat zabilježen je u skupini nastavnika biologije (srednja vrijednost: 84,56- najviša razina). Najniži je rezultat zabilježen u skupini odgojitelja (69,68).

U skupinama nastavnika predmetne nastave (prirodne znanosti) razina prihvaćanja je visoka (srednja vrijednost: 78,46), uglavnom zbog biologa, ali i kemičari imaju visok rezultat (srednja vrijednost: 78,82).

Uzimajući u obzir skupine nastavnika predmetne nastave, možemo vidjeti da su postigli bolje rezultate od učitelja i odgojitelja.

Neke od tih razlika su značajne (učitelji – odgojitelji, razlika u srednjoj vrijednosti = 4,31, nivo povjerenja <0,05. Nastavnici predmetne nastave – nastavnici razredne nastave, razlika u srednjoj vrijednosti = 4,48, nivo povjerenja <0,01. Nastavnici predmetne nastave – odgojitelji, razlika u srednjoj vrijednosti = 8,78, nivo povjerenja <0,01) .

Nastavnici biologije postigli su bolje rezultate u usporedbi s drugim skupinama nastavnika. To je u skladu s njihovom obrazovanjem. Možemo vidjeti da su značajne razlike primjetno između biologa – kemičara, razlika u srednjoj vrijednosti = 5,75, nivo povjerenja <0.01, biologa – fizičara, razlika u srednjoj vrijednosti = 12,64, nivo povjerenja <0,01.

Tablica 7.

b) ***razumijevanje:***

U svim skupinama nastavnika razina razumijevanja je vrlo niska (ukupna srednja vrijednost: 5,82 boda).

Nastavnici predmetne nastave (prirodne znanosti) imali su bolji rezultat u razumijevanju od nastavnika razredne nastave i odgojitelja. Najviše bodova imaju nastavnici predmetne nastave (srednja vrijednost bodova: 6,34), a najniži broj bodova dobili su odgojitelji (srednja vrijednost bodova: 4,42).

Neke od tih razlika su značajne, osobito: Nastavnici predmetne nastave – odgojitelji, razlika u srednjoj vrijednosti = 1,91, nivo povjerenja <0,01, nastavnici predmetne nastave – nastavnici razredne nastave, razlika u srednjoj vrijednosti = 1,01, nivo povjerenja <0,01 i nastavnici razredne nastave – odgojitelji, razlika u srednjoj vrijednosti = 0,90, nivo povjerenja < 0,05.

Najviši je rezultat u skupini nastavnika biologije u usporedbi s drugim skupinama nastavnika. Taj je rezultat u skladu s činjenicom da nastavnici biologije tijekom školovanja imaju nastavne sadržaje iz evolucije. Rezultat je nešto bolji, ali je njihov rezultat još uvijek na nižoj razini. Postoje značajne razlike u rezultatima u razumijevanju između: biologa – fizičara, razlika u srednjoj vrijednosti = 1,65, nivo povjerenja <0,01 i biologa – kemičara, razlika u srednjoj vrijednosti = 1,12, nivo povjerenja <0,01.

c) ***korelacije:***

U tablici 8. prikazana je korelacija (Pearson) između ispitivanih čimbenika (prihvaćanje i razumijevanje teorije evolucije) za nastavnike iz Srbije (u cjelini).

Tablica 8**.**

U tablici 8. možemo vidjeti da postoji pozitivna korelacija između prihvaćanja i razumijevanja teorije evolucije za sve skupine nastavika iz Srbije *(r* = 0,353, p <0,01). Rezultati pokazuju da je jačina povezanosti između prihvaćanja i razumijevanja ET visoka *(r* = 0,353) i da se koeficijent korelacije vrlo značajno razlikuje od nule (p <0,01). Pozitivna korelacija ukazuje na to da se obje varijable zajedno povećavaju ili smanjuju.

Naši rezultati mogu se usporediti s rezultatima drugih studija koje istražuju prihvaćanje ET (mjereno MATE ljestvicom). Nedavna usporedna studija grčkih nastavnika pokazuje da grčki nastavnici imaju bolje rezultate u razumijevanju teorije evolucije u odnosu na skupinu nastavnika iz Srbije, ali ne postoji značajna razlika između grčkih i srbijanskih nastavnika u prihvaćanju teorije evolucije u cjelini, ali postoje značajne razlike između različitih skupina nastavnika (Papadopoulou i sur., 2011).

Rezultati nastavnika biologije iz Srbije vrlo su slični rezultatima nastavnika biologije iz Oregona koji su postigli 85,90 za srednju vrijednost bodova za prihvaćanje (Trani, 2004). Budući da su turski nastavnici biologije ostvarili samo 50,95 za srednju vrijednost bodova za prihvaćanje (Deniz i sur., 2008.), što je slabo postignuće u usporedbi s rezultatima svih skupina srbijanskih nastavnika. Srbijanski nastavnici biologije također imaju bolje rezultate prihvaćanja u usporedbi s nastavnicima biologije iz Indijane koji su postigli 77,59 za srednju vrijednost bodova za prihvaćanje (Rutledge i Warden, 2000).

Uzimajući u obzir druge kategorije nastavnika, nastavnici predmetne i razredne nastave iz Novog Zelanda postigli su 84,55 za srednju vrijednost bodova za prihvaćanje (Campbell i Cook, 2003), što je vrlo slično rezultatima srbijanskih nastavnika biologije. Drugi nastavnici (izuzev biologa) iz Sjedinjenih Američkih Država ostvarili su samo 55,87 za srednju vrijednost bodova za prihvaćanje (Rutledge i Sadler, 2007), što je vrlo nizak rezultat u usporedbi s rezultatima svih srbijanskih nastavničkih skupina.

Naši rezultati pokazuju da je razumijevanje teorije evolucije povezano s prihvaćanjem teorije evolucije. Ti su rezultati u skladu s drugim rezultatima (Rutledge i Warden, 2000; Johnson i Peeples, 1987; Deniz i sur., 2008; Peker i sur., 2010). Neke su studije potvrdile da ne postoji značajana povezanost između tih varijabli (Akyol i sur., 2010; Annaç i Bahçekapili, 2012; Brem, Ranney i Schindel, 2003; Demastes i sur., 1995; Sinatra i sur., 2003.).

Zaključci i implikacije

Na temelju dobivenih rezultata, prikazanih za srbijanske skupine nastavnika, može se zaključiti da postoje razlike u prihvaćanju i razumijevanju ET među skupinama srbijanskih nastavnika, u skladu s njihovim obrazovanjem.

Razina prihvaćanja je umjerena u ukupnoj skupini. U skupini nastavnika predmetne nastave razina prihvaćanja je visoka. Nastavnici biologije pokazuju bolje rezultate u usporedbi s drugim skupinama nastavnika. Najniži broj bodova je u skupini odgojitelja.

Razine razumijevanja također su vrlo niske. Postoje statistički značajne razlike među skupinama nastavnika. Posebno su značajne razlike za odgojitelje. Oni su imali najniži broj bodova.

Nastavnici biologije imaju veće rezultate za razumijevanje i prihvaćanje u usporedbi s drugim skupinama nastavnika predmetne nastave (kemičari, fizičari). Oni imaju

I bolje rezultate od skupina nastavnika razredne nastave i odgojitelja. To se može objasniti postojanjem velikog broja evolucijskih nastavnih sadržaja na njihovim studijima, u usporedbi s drugim skupinama nastavnika koji imaju manje evolucijskih nastavnih sadržaja.

Utvrdili smo da postoji pozitivna korelacija između prihvaćanja i razumijevanja teorije evolucije kod srbijanskih nastavnika.

Niska razina prihvaćanja i razumijevanja ET predstavljaju izazove s kojima se srbijanski obrazovni sustavi trebaju suočiti ako se nadaju osigurati legitimno biološko obrazovanje. Samo bolji rezultati nastavnika biologije (za prihvaćanje i razumijevanje ET) u korelaciji s drugim skupinama nastavnika mogu se objasniti postojanjem evolucijskih nastavnih sadržaja na njihovim studijima. Također, u Srbiji su svi evolucijski nastavni sadržaji loše objašnjeni u udžbenicima za sve razine nastave biologije (osnovne škole, srednje škole, pa čak i na Biološkom fakultetu). Naši rezultati poazuju da se može izvesti nekoliko preporuka u cilju promoviranja razumijevanja i prihvaćanja teorije evolucije:

Nužno je poboljšati evolucijske nastavne sadržaje u srbijanskom obrazovnom sustavu za sve skupine nastavnika (koji su sudjelovali u ovom istraživanju), pogotovo za odgojitelje i nastavnike razredne nastave.

Postoji potreba za promjenom i didaktičkom pripremom svih evolucijskih nastavnih sadržaja, osobito u udžbenicima i tečajevima. To će biti više prikladno za stjecanje znanja u tom nastavnom području.

Pravilno postavljanje predavanja i učenja evolucije u općoj strukturi nastave biologije može dovesti do povećanja njezina prihvaćanja. Athanasiou i Papadopoulou (2011) pokazuju da jedan od načina treba biti organiziranje nastave biologije o temi evolucije kao nastavnom okviru.

Nastavnici bi imali koristi od dodatne obuke nastave evolucije ako bi bila dobro metodički pripremljena. Mnogi nastavnici dolaze u razred s prethodnim pogrešnim koncepcijama o evoluciji (Pigliucci, 2007). Kad bi se bavili tim pogrešnim koncepcijama i rasvijetlili ih, prihvaćanje i razumijevanje evolucije bilo bi bolje promovirano (Verhey, 2005; Robbins i Roy, 2007). Njihovi stavovi i razumijevanje evolucije može utjecati na njihove odluke u vezi s poučavanjem evolucije u njihovim učionicama.

Ako bi se navedene preporuke široko primijenile, proces obrazovanje nastavnika u ovom nastavnom području bio bi puno kvalitetniji.

Zahvale

Autori bi željeli izraziti zahvalnost *Ministarstvu prosvjete i nauke Republike Srbije* (Projekt broj 173038) i *Glavnom tajništvu za istraživanje i tehnologiju Grčke* (Projekt br. GSRT 04965/2010) za financijsku potporu.

Dodatak. Upitnik o prihvaćanju i razumijevanju teorije evolucije

A. Demo*grafski podaci*

1. Spol

☐ Muški ☐ Ženski

2. Starost

☐ <30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ > 60

3. Stručnost

☐ Biolog ☐ Kemičar ☐ Fizičar ☐ Učitelj ☐ Odgojitelj

4. Godina nastavnog iskustva ☐

5. Poslijediplomski studiji ☐

B. PRIHVAĆANJE TEORIJE EVOLUCIJE (MATE ljestvica)

1 = potpuno se ne slažem, 2 = ne slažem se, 3 = nemam mišljenje, 4 = slažem se, 5 = potpuno se slažem

	1	2	3	4	5
1. Evolucija je znanstveno valjana teorija.					
2. Organizmi koji danas postoje rezultat su evolucijskih procesa koji su se dogodili tijekom milijuna godina.					
3. Teorija evolucije temelji se na spekulaciji, a ne na valjanom znanstvenom promatranju i ispitivanju.					
4. Moderni ljudi proizvod su evolucijskih procesa koji su se dogodili tijekom milijuna godina.					
5. Postoji značajna količina podataka koji podržavaju teoriju evolucije.					
6. Većina znanstvenika prihvaća teoriju evolucije kao znanstveno valjanu teoriju.					
7. Teorija evolucije ne može se znanstveno ispitati.					
8. Teorija evolucije ne može biti točna jer se ne slaže s biblijskim činom stvaranja.					
9. Uz nekoliko iznimaka, organizmi na Zemlji nastali su otprilike u isto vrijeme.					
10. Starost Zemlje je manja od 20.000 godina.					
11. Teorija evolucije donosi smisao različitim karakteristikama i ponašanjima promatranim u živim bićima.					
12. Teorija evolucije generira provjerljiva predviđanja s obzirom na obilježja života.					
13. Organizmi postoje i danas u gotovo istom obliku koji oduvijek imaju.					
14. Evolucija nije znanstveno valjana teorija.					
15. Velik dio znanstvene zajednice sumnja da se evolucija događa.					
16. Trenutna teorija evolucije rezultat ke valjanih znanstvenih istraživanja i metodologije.					
17. Teorija evolucije podržana je činjeničnim, povijesnim i laboratorijskim podacima.					
18. Ljudi danas postoje u istom obliku koji oduvijek imaju.					
19. Starost Zemlje je oko 4-5 milijardi godina.					
20. Dostupni dokazi su dvosmisleni u odnosu na to da li se evolucija događa.					

C. RAZUMIJEVANJE TEORIJE EVOLUCIJE

1 = Točno, 2 = Netočno, 3 = Ne znam

	1	2	3
1. Teorija evolucije koju je predložio Charles Darwin ticala se spontane generacije novih organizama.			
2. Evolucija govori o ljudskom porijeklu od predaka nalik majmunima.			
3. Prve životinje koje su se naselile na kopnu vjerojatno su djelomice ovisile o vodi.			
4. Prema Darwinu, jedinke u populaciji imaju trend reproduciranja u geometrijskoj stopi rasta.			
5. U Darwinovo doba nisu bili pozbati točni mehanizmi koji objašnjavaju genetsko naslijeđe.			
6. U (modernoj) Darwinovoj teoriji predloženo je da izmjene koje organizam stječe tijekom svog životnog vijeka može prenijeti na svoje potomke.			
7. Prema teoriji prirodne selekcije, populacije se mijenjaju tijekom vremena kao odgovor na promjene u okolišu.			
8. Lamarkova glavna ideja u procesu evolucije ticala se nasljeđivanja stečenih osobina.			

9. Jedinke u sisavaca imaju tendenciju genetskog razlikovanja. Primarni mehanizam generiranja te genetske varijabilnosti je:
   A. mejoza
   B. mitoza
   C. poliploidija
   D. duplikacija

10. Za krilo šišmiša i prednje udove psa kaže se da su homologne strukture. To pokazuje da:
   A. one imaju istu strukturu
   B. su se šišmiši razvili iz linije pasa
   C. su one strukture slične s obzirom na zajedničke pretke
   D. imaju drugačije porijeklo, ali zajedničku funkciju

11. Morski sisavci imaju mnoge strukturne karakteristike zajedničke s ribama. Objašnjenje koje bi teorija evolucije dala za tu sličnost je:
   A. Ribe i sisavci su blisko povezani.
   B. Riba je razvila strukture slične onima koje postoje u sisavaca.
   C. Morski sisavci su se razvili izravno od riba.
   D. Morski sisavci su se prilagodili okolini sličnoj kao ribe.

12. Metoda datiranja s pomoću radioaktivnog ugljika:
   A. Pomaže u datiranju starosti ostatka organizama, ali je u stanju identificirati kratko vremensko razdoblje (40.000 godina).
   B. Pomaže u datiranju starosti ostataka organizama i u mogućnosti je identificirati dugo vremensko razdoblje.
   C. Nije pouzdana tehnika.
   D. Koristi se samo za stijene, ne i za ostatke organizama.

13. Izmjene u rasporedu nukleotida u kromosomu, koje dovode ili do strukturne ili do fiziološke promjene u organizmu zovu se:
   A. genetski drift
   B. mutacije
   C. prirodna selekcija
   D. recesivan gen